Unit 11: Physiology of Human Body Systems

Unit code: F/502/5550

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to enable learners to investigate some of the organ systems of the human body and how they work together. Learners will have an opportunity to use appropriate tests to investigate the cardiovascular, respiratory, digestive and lymphatic systems and the organisation of cells and tissues.

Unit introduction

This unit will give learners an insight into how the human body works. There are 10 major systems within the human body, which work together as one unit. Physiology is the study of the physical and biochemical functions of these.

This unit will focus on four of the fundamental systems: cardiovascular; respiratory; digestive and lymphatic. An understanding of the functioning of the human body is essential for many careers in health, science, and allied professions.

Learners will focus on each of the systems as a functioning unit, identifying the organs that make up the system and the tissues that comprise them. They will learn to recognise the link between structure and function of cells, and in so doing, understand the organisation of normal tissue, which they can compare with diseased tissue found in many common illnesses. They will also learn the clinical signs when things go wrong with the body.

Learners will conduct experiments and use apparatus in order to investigate how the various human physiology systems work. They will interpret data and draw conclusions, much the same as a laboratory technician might do.

The unit will help learners develop their practical and analytical skills, and increase their knowledge and understanding of human physiology systems. This unit builds upon *Unit 1: Fundamentals of Science*, and complements *Unit 12: Physiology of Human Regulation and Reproduction*, which focuses on the control and management of bodily systems.

Learning outcomes

On completion of this unit a learner should:

1 Know the levels of organisation within the human body

2 Be able to relate the structure of the circulatory system to its function in a multi-cellular organism

3 Be able to relate the structure of the respiratory system to its function

4 Be able to relate the structure of the digestive system to its function

5 Understand the immunological function of the lymphatic system.

Unit content

1 Know the levels of organisation within the human body

Ultrastructure of an animal cell: plasma membrane; cytoplasm; nucleus; nucleolus; endoplasmic reticulum; golgi apparatus; vesicles; lysosomes; ribosomes; mitochondria; centrioles

Tissue types: epithelial (glandular, lining, covering), eg salivary gland of digestive tract, endothelial lining of arteries and veins in the cardiovascular system, epithelial lining of lung tissue in the respiratory system; muscular, eg smooth muscle surrounding the gastrointestinal tract, skeletal muscle, intercostal muscles of the lungs, cardiac muscle of the heart; nervous, eg neurones and neuroglia; involuntary innervation throughout the body systems; connective, diverse group, cartilage, bone (eg ribs in respiratory system), areolar (within mucous membranes of the digestive system), adipose, elastic (fibres in artery walls within cardiovascular system), reticular, collagenous

Levels of organisation: through differentiation, cells form tissues; organs; organ systems

Light and electron microscopes: magnification and resolution

2 Be able to relate the structure of the circulatory system to its function in a multi-cellular organism

Structure of the cardiovascular system: blood, eg erythrocytes, leucocytes, plasma; heart (chambers, vessels including coronary, valves); cardiac cycle; blood vessels (arteries, veins, arterioles, venules, capillaries); blood pressure, blood flow, eg major circulatory routes, systemic, cerebral, hepatic, pulmonary; use of laboratory techniques in the examination of blood components

Functions of the cardiovascular system: transporting substances, eg gases, nutrients, waste, hormones, heat, defence, eg blood clotting, phagocytes, macrophages, B & T lymphocytes; regulation of temperature, pH, water content; measurement of the function of cardiovascular system in a range of situations

Rate of diffusion: large diffusion distances in multi-celled organism dictate the need for a transport system

3 Be able to relate the structure of the respiratory system to its function

Structure of the respiratory system: mouth; nasal cavities; pharynx; larynx; trachea; bronchi; bronchioles; alveoli; capillary network

Adaptations: thin diffusion pathway, large surface area, high concentration gradients

Functions of the respiratory system: breathing (inspiration, expiration); respiration – gaseous exchange, eg pulmonary, pulmonary volumes, pulmonary capacities; interpretation of spirometer readings; measurement of the functions of the respiratory system

4 Be able to relate the structure of the digestive system to its function

Essential dietary nutrients: carbohydrates; lipids; proteins; vitamins; minerals; fibre; water; chemical structure of nutrients and their role in metabolism to provide structural or regulatory molecules; role of minerals and vitamins in the enzyme system

Biochemical food tests: starch, reducing sugars, protein, lipid, vitamin C, flame tests for ions

Structure of the digestive system: mouth; pharynx; oesophagus; stomach; pancreas; liver; gall bladder; small intestine; large intestine; details of cell structure in relation to their functions for the stomach, pancreas, liver, small and large intestines

Functions of the digestive system: ingestion; mechanical digestion; chemical digestion including sites of synthesis and action of digestive enzymes; absorption, eg active transport and diffusion, the role of the lymphatic system in the absorption of lipids; egestion; practical investigation of chemical digestion

5 Understand the immunological function of the lymphatic system

Structure of the lymphatic system: lymphatic vessels; lymph organs, eg spleen, thymus gland, tonsils; lymph; only gross structure required

Functions of the lymphatic system: drainage of tissue fluid and formation of lymph; outline of defensive role

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 describe the organisation of the eukaryotic cell in terms of the functions of the organelles [IE1]	**M1** use diagrams or micrographs to compare and contrast the four tissue types	**D1** explain the relationship between cells, tissues, organs and organ systems in the organisation of the human body
P2 describe the four different tissue types [IE1]		
P3 take measurements related to the cardiovascular system, relating the results to the function of the cardiovascular system [TW1,2,3]	**M2** explain the need for transport systems in a multi-cellular organism	**D2** explain how the digestive, cardiovascular and respiratory systems are interrelated
P4 take measurements related to the respiratory system, relating the results to the function of the respiratory system [TW1,2,3]	**M3** explain the need for ventilation systems in a multi-cellular organism	
P5 use appropriate chemical tests to identify different dietary nutrients [EP3]	**M4** use chemical equations to show how the main food groups are dealt with in the digestive system	
P6 explain how these dietary nutrients are processed through the digestive system		
P7 describe the structure and purpose of the lymphatic system.	**M5** explain how the lymphatic system protects the body.	**D3** explain the difference in lymphatic function in health and disease state.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key			
	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

The purpose of this unit is to develop understanding of the levels of organisation within the body, from the most basic unit, the cell, through the process of differentiation to form tissues and how these tissues are coordinated within an organ and an organ system. Learners will learn about and investigate the communication and coordination between systems under changing conditions and stresses.

This unit requires learners to build up a bank of knowledge about the human body and then apply it, in order to interpret data collected from the respiratory and cardiovascular systems through physiological measurement under different conditions.

Complementing their physiological investigations, learners will undertake biochemical testing as a model of function within the digestive system.

Learning outcome 1 covers the essential information on which the rest of the unit is based. A combination of approaches should be employed, including formal lectures, investigation by learners through a variety of sources and practical work including microscopy and cell/tissue manipulation. By the end of this outcome learners should have an understanding of the levels of organisation in the whole body, and the interplay between the different body systems.

Learning outcome 2 should be practical and based in a laboratory or gymnasium in which physiological measurements can be taken. Learners will use the basic knowledge built up through learning outcome 1 to interpret measurements collected from the cardiovascular system. By the end of this outcome learners should know about the relationship between structure and function of the cardiovascular system.

Learning outcome 3 is also practical and, because of the interrelationship between the respiratory and cardiovascular systems, may be dealt with alongside with learning outcome 2. As a result of practical physiological investigation, learners should be aware of the connection between the structure of the respiratory system and its function as the site of gaseous exchange, and the adaptation shown under varying conditions and stresses.

Learning outcome 4 will give learners an understanding of the role of essential nutrients, their food origins, processing by the body and use within cells. Learners will use biochemical testing to investigate foodstuffs and their processing by the body, including their enzymic breakdown into basic units. As well as biochemical testing of basic nutrients, there is scope within this learning outcome for learners to undertake quantitative investigation of essential nutrients.

Learning outcome 5 could be delivered through lecture-based seminars and learner investigation, especially related to health and disease. This learning outcome introduces learners to the lymphatic system, how it functions and what may happen in malfunction. Internet-based research is essential for this learning outcome and could take the form of investigation into specified disease states, including autoimmune disease.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to the unit and programme of assignments.
Learning outcome 1 Tutor input: cells, tissues and the organisation of the human body. Practical work: microscope work; cell/tissue manipulation. Discussion: interrelationship between different body systems. **Assignment 1: Levels of Organisation of the Human Body (P1, P2, M1, D1)**
Learning outcome 2 Tutor input: revisiting the cardiovascular system. Practical work: taking measurements; exercise physiology experiments. **Assignment 2: Physiology of the Cardiovascular System (P3, M2, D2)**
Learning outcome 3 Tutor input: revisiting the respiratory system. Practical work: structure and function of the respiratory system. **Assignment 3: Physiology of the Respiratory System (P4, M3, D2)**
Learning outcome 4 Tutor input: essential nutrients and their food origins, how they are processed. Practical work: Biochemical tests. Detail of breakdown of food groups along GIT, relate structure to function. Regulation of blood sugar levels in health and disease. **Assignment 4: Nutritional Content of Foodstuffs (P5, P6, M4, D2)**
Learning outcome 5 Tutor input: seminars/lectures on lymphatic system, immunology, health and disease. Learner research: looking into specific disease states. **Assignment 5: The Lymphatic System (P7, M5, D3)**
Review of unit and assignment programme.

Assessment

Wherever possible, this unit should be assessed through practical investigation and report writing, illustrating learners' evaluative skills. Initially, identification of tissues may be verified through the creation of a portfolio of evidence illustrating learners' knowledge and understanding in support of the learning outcomes.

As all the learning outcomes are related, practical investigations covering several learning outcomes simultaneously may be employed, but reporting and evaluation can be multifaceted, incorporating one or more of the following methods: laboratory reports; presentations (including posters); magazine or website articles; graphs and charts.

Pass grade learners will receive considerable guidance from tutors in order to achieve the learning outcomes.

For P1, learners must describe the organisation of a eukaryote cell in terms of how organelles function. This could take the form of a flow chart illustrating the concept. For P2, learners must describe the four different tissue types. For M1, learners must explain the process of differentiation forming the four tissue types, for example through a presentation illustrating the process and how this may influence the organelles or structure of the cells. For D1, learners must explain the levels of organisation, from organelles of a eukaryote cell to an organ system. This could take the form of a flow chart illustrating the concept, with annotated illustrations showing the interrelationship between the levels.

For P3 and P4, learners must collect data competently from physiological investigation of the cardiovascular and respiratory systems and be able to use the data to relate structure to function.

For M2, learners must give careful consideration to all the factors involved in a human transport system and then show how the body deals with the requirements. For example, how does the body deal with the constant leakage of fluid from the cells? Which part of the transport system ensures this intracellular fluid is returned? Evidence could be presented in an annotated diagrammatic form using appropriate software.

Learners must undertake a similar consideration for M3 and they did for M2, to explain the need for the respiratory system.

For D2, learners must use analytical skills to link the functions of three body systems. Homeostasis may be mentioned but it is dealt with further in another unit. The emphasis here is on identifying the functions of each system and showing how they are interrelated. Again, this work lends itself to annotated diagrams with explanatory text rather than a long essay.

For P5 and P6, learners must take accurate measurements using biochemical tests, understand their implications for digestive functioning and relate this to the needs of the body.

For M4, learners must know where the major food groups are processed in the digestive system. Learners must provide chemical equations for the digestion of the main food groups and explain how the body is adapted to use these molecules. Learners must identify macro- and micronutrients, and they must explain their role in maintaining the health and function of the body. Learners do not need to discuss deficiencies in nutrition, but they should not be discouraged from displaying an awareness of this.

For P7, learners must explain the structure of the lymphatic system and its role in protecting the body. This could take the form of a poster annotated to illustrate the function of each component. For M5, learners must explain how the lymphatic system protects the body. A range of sources should be used to exemplify learners' work. For D3, learners must use data evaluation to illustrate lymphatic functional loss in disease and explain the underlying mechanisms. Learners must be able to explain the difference in lymphatic function in health and disease state.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1, D1	Levels of Organisation of the Human Body	You are a public awareness officer working for tissue engineering department.	Annotated leaflet illustrating different levels of organisation.
P3, M2, (part) D2	Physiology of the Cardiovascular System	You are a cardiology department technician measuring patient function.	Carry out investigation and report findings.
P4, M3, (part) D2	Physiology of the Respiratory System	You are a pulmonary diseases department technician investigating patient lung function.	Carry out investigation and report findings.
P5, P6, M4, (part) D2	Nutritional Content of Foodstuffs	You are a forensic laboratory technician investigating the nutritional content of foodstuffs.	Carry out investigation and produce a report.
P7, M5, D3	The Lymphatic System	You are a patient information officer for your local hospital department.	Illustrated poster showing the role of the lymphatic system in health and disease.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Applied Science sector suite. This unit has particular links with the units shown below in the BTEC Applied Science suite of qualifications:

Level 2	Level 3
Biology and our environment	Physiology of Human Regulation and Reproduction
	Physiological Investigations

Essential resources

Learners will require laboratory equipment to measure physiological function: cardiovascular; respiratory and biochemical testing/chemical digestion (illustrating digestive function).

They also need access to anatomical models, microscopes and pre-prepared slides and photomicrographs.

Learners will also require access to textbooks, journals, scientific databases, CD ROMs, websites, and patient information leaflets.

Employer engagement and vocational contexts

A visit to a hospital, industrial or research facility conducting physiological testing would be of great benefit to learners, as would work experience in one of these centres. In the absence of these, visiting speakers/experts such as nurses, laboratory staff, diabetes awareness practitioners would be useful.

Indicative reading for learners

Textbooks

Adds J et al – *Respiration and Coordination (Nelson Advanced Science: Biology Series)* (Nelson Thornes, 2005) ISBN 9780748774890

Boyle M et al – *Human Biology (Collins Advanced Science Series)* (Collins Educational, 2002) ISBN 9780007135998

Fullick A – *Body Systems and Health (Life Science In Depth)* (Heinemann, 2006) ISBN 9781403475190

Johnson M D – *Human Biology: Concepts and Current Issues, 3rd Edition* (Benjamin Cummings, 2005) ISBN 9780805354348

Parkinson P – *'A' Level Human Biology: Advanced Subsidiary (AS) Human Biology* (2000) ISBN 9781853568961

Parkinson P – *'A' Level Human Biology: Advanced GCE (A2) Human Biology* (2000) ISBN 9781853568978

Pickering W R – *A-level Advanced Human Biology Through Diagrams* (Oxford University Press, 2001) ISBN 9780199141968

Simpkins J and Williams J I – *Advanced Human Biology* (Collins Educational, 1987) ISBN 9780003222906

Tortora G J – *Principles of Anatomy and Physiology* (John Wiley & Sons, 2005) ISBN 9780471718710

Tucker L – *An Introductory Guide to Anatomy and Physiology* (EMS Publishing, 2008) ISBN 9781903348284

Journals

American Journal of Physiology

Journal of Applied Physiology

Journal of Exercise Physiology

Journal of Physiology

Open Physiology Journal

Websites

www.bbc.co.uk/health	BBC Health
www.biologyguide.net	A-level revision site for Biology
www.nhsdirect.nhs.uk	NHS Direct patient information leaflets
www.physoc.org	The Physiological Society
www.s-cool.co.uk	GCSE and A-level revision site
www.sedoparking.com/sciencepages.co.uk	Science Pages – links

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	[IE1] investigating tissues and cells
Team workers	[TW1,2] carrying out measurements of cardiac and respiratory function [TW3] having measurement of cardiac and respiratory function taken by peers
Effective participators	[EP3] using appropriate chemical tests to identify nutrients.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Creative thinkers	[CT5] predicting results to fit scenario
Reflective learners	[RL5] understanding results and anomalies related to underlying physiology function
Team workers	[TW1] collaborating in investigative tasks
Self-managers	[SM2,3] directing own/team effort to collect data
Effective participators	[EP2] presenting work to their group.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	researching collecting, manipulating and presenting data doing a verbal presentation with the use of slide and/or interactive whiteboard
Manage information storage to enable efficient retrieval	storing results in a spreadsheet
Follow and understand the need for safety and security practices	identifying health and safety issues and completing risk assessments online
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching sources of information in investigative task
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	accessing epidemiological and physiological data
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	using text and tables to prepare report using images including graphs to draw conclusions within report and supporting numerical data taking records and manipulating them in experiments
Bring together information to suit content and purpose	researching and presenting work
Present information in ways that are fit for purpose and audience	presenting in a variety of ways including reports, verbal presentations, posters, articles and information leaflets
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	evaluating secondary data to support argument
Identify the situation or problem and the mathematical methods needed to tackle it	appropriately manipulating of data collected in support of experimental ideas
Select and apply a range of skills to find solutions	using trend lines, rate calculations and averages for evaluation of data
Use appropriate checking procedures and evaluate their effectiveness at each stage	during practical investigation
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	interpreting primary and secondary data sources
Draw conclusions and provide mathematical justifications	evaluating experimental work

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	taking useful notes during teacher and peer-led discussion, making verbal contribution in group discussion and presentation of own work
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	gathering information from a variety of sources and levels during investigative tasks
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing reports, articles and posters.